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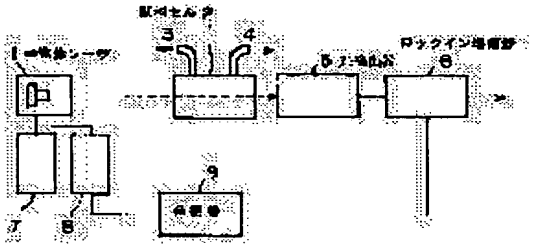
(54) CARBON ISOTOPE ANALYZING INSTRUMENT

(57)Abstract:
PURPOSE: To provide a carbon isotope analyzing instrument which has high sensitivity and accuracy and, at the same time, can trace the carbon isotope ratio without receiving any influence from the spectrum of water, etc.
CONSTITUTION: Objects to be analyzed, namely, 12CO2 and 13CO2 are put in a sample cell 2, and parts of the objects are absorbed by resonance by irradiating the objects with semiconductor laser light in a near infrared region. At the same time, residual light rays having different intensities from the objects are introduced to a lock-in amplifier 6 after detecting the light rays with a photodetector 5. The amplifier 6 detects the intensity ratio between the absorption spectrum of the light from the 12CO2 when the emission wavelength of a semiconductor laser 1 is 6253.73±0.2 [cm-1] and the light of the 13CO2 when the emission wavelength is 6253.90 [cm-1].



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] a light absorption spectral intensity ratio — being based — two or more carbon isotope 12CO2 and 13COs2 In the isotopic analysis equipment which detects the isotopic ratio of the intermingled specimen The semiconductor laser of a near infrared ray, and the means which carries out the sweep of the oscillation wavelength of this semiconductor laser, The frequency modulation means which applies frequency modulation to this semiconductor laser, and the photodetector which detects the laser beam which passed the specimen in which it is emitted from this semiconductor laser and said two or more carbon isotopes are intermingled, It has the lock-in amplifier which detects adjustment with the modulation frequency obtained with said frequency modulation means, and the signal frequency of said laser beam detected with said photodetector. The luminescence wavelength of said semiconductor laser is 12COs2 at the time of wave number 6253.73**0.2 cm-1. Light absorption spectrum, 13COs2 in case luminescence wavelength is similarly wave number 6253.90 cm-1 Carbon isotopic analysis equipment characterized by detecting an intensity ratio with a light absorption spectrum.
[Claim 2] 12COs2 in case said light absorption spectral intensity ratio is [the luminescence wavelength of said semiconductor laser] wave number 6254.67**0.2 cm-1 Light absorption spectrum, 13COs2 in case luminescence wavelength is wave number 6255.14**0.2 cm-1 12COs2 in case an intensity ratio with a light absorption spectrum and luminescence wavelength are wave number 6255.58**0.2 cm-1 Light absorption spectrum, 13COs2 in case luminescence wavelength is wave number 6255.14**0.2 cm-1 12COs2 in case an intensity ratio with a light absorption spectrum and luminescence wavelength are wave number 6257.29**0.2 cm-1 Light absorption spectrum, 13COs2 in case luminescence wavelength is wave number 6257.51**0.2 cm-1 12COs2 in case an intensity ratio with a light absorption spectrum and luminescence wavelength are wave number 6258.88**0.2 cm-1 Light absorption spectrum, 13COs2 in case luminescence wavelength is wave number 6258.64**0.2 cm-1 12COs2 in case an intensity ratio with a light absorption spectrum and luminescence wavelength are wave number 6261.01**0.2 cm-1 Light absorption spectrum, 13COs2 in case luminescence wavelength is wave number 6260.80**0.2 cm-1 12COs2 in case an intensity ratio with a light absorption spectrum and luminescence wavelength are wave number 6261.65**0.2 cm-1 Light absorption spectrum, 13COs2 in case luminescence wavelength is wave number 6261.83**0.2 cm-1 12COs2 in case an intensity ratio with a light absorption spectrum and luminescence wavelength are wave number 6252.77**0.2 cm-1 Light absorption spectrum, 13COs2 in case luminescence wavelength is wave number 6252.63**0.2 cm-1 12COs2 in case an intensity ratio with a light absorption spectrum and luminescence wavelength are wave number 6251.77**0.2 cm-1 Light absorption spectrum, 13COs2 in case luminescence wavelength is wave number 6251.32**0.2 cm-1 12COs2 in case an intensity ratio with a light absorption spectrum and luminescence wavelength are wave number 6249.67**0.2 cm-1 Light absorption spectrum, 13COs2 in case luminescence wavelength is wave number 6249.98**0.2 cm-1 12COs2 in case an intensity ratio with a light absorption spectrum and luminescence wavelength are wave number 6228.69**0.2 cm-1 Light absorption spectrum, 13COs2 in case luminescence wavelength is wave number 6228.44**0.2 cm-1 12COs2 in case an intensity ratio with a light absorption spectrum and luminescence wavelength are wave number 6231.72**0.2 cm-1 Light absorption spectrum, 13COs2 in case luminescence wavelength is wave number 6232.03**0.2 cm-1 12COs2 in case an intensity ratio with a light absorption spectrum and luminescence wavelength are wave number 6233.19**0.2 cm-1 Light absorption spectrum, 13COs2 in case luminescence wavelength is wave number 6233.77**0.2 cm-1 12COs2 in case an intensity ratio with a light absorption spectrum and luminescence wavelength are wave number 6226.35**0.2 cm-1 Light absorption spectrum, 13COs2 in case luminescence wavelength is wave number 6226.59**0.2 cm-1 12COs2 in case an intensity ratio with a light absorption spectrum and luminescence wavelength are wave number 6223.13**0.2 cm-1 Light absorption spectrum, 13COs2 in case luminescence wavelength is wave number 6222.79**0.2 cm-1 Carbon isotopic analysis equipment according to claim 1 characterized by being an intensity ratio with a light absorption spectrum.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention irradiates light at the sample matter with which two or more carbon isotopes are intermingled, and relates to the carbon isotopic analysis equipment which asks for the ratio of an isotope based on the light absorption spectral intensity ratio.
[0002]
[Description of the Prior Art] An isotope exists in a nature slightly and it can use for trace of an ecosystem by a diagnosis sick in the medicine field, and the agricultural field by tracing change of this isotope in research of the metabolism of the research and the vegetation of photosynthesis, and the earth science field.
[0003] There are nitrogen and carbon as an isotope used for such an application. Especially, with carbon, there is a stable isotope of the carbon (it is written as 12C below) of the mass number 12 and the carbon (it is written as 13C below) of the mass number 13. These stable isotopes do not have radiation contamination like radioisotope, and since handling is easy, use in the medical field is studied positively.
[0004] As an analysis apparatus of the above-mentioned stable isotope, an example of the equipment currently used conventionally is shown in drawing 4 . the inside of drawing, the lamp of the luminescence wavelength range of an infrared region with large ten, and 11 — a sample cell and 12 — for a distributed spectroscope and 15, as for a diffraction grating and 17, a mirror and 16 are [a sample gas inlet and 13 / sample gas exhaust and 14 / a slit and 18] photodetectors.
[0005] With this equipment, sample gas is introduced in a sample cell 11 from the sample gas inlet 12, and is discharged from the sample gas exhaust 13. Incidence of the light which came out of the lamp 10 is carried out to a sample cell 11, it interacts with the sample gas in a sample cell 11, and resonance absorption of the part is carried out. A residual light passes a sample cell 11, it goes into the distributed spectroscope 14, a beam direction is changed by the mirror 15, and a diffraction grating 16 irradiates. And the optical reinforcement of the wavelength by which wavelength dispersion was made by the diffraction grating 16, and wavelength selection was made to the slit 17 is detected by the photodetector 18. By rotating the include angle of a diffraction grating 16 continuously in the direction of theta here, selection wavelength is changed and the light absorption spectrum of sample gas is measured.
[0006] In addition, since carbon does not resonate the light of an infrared region, and directly in measurement, after making it a carbon dioxide (CO2) beforehand, it will be introduced to a sample cell 11, and the spectrum will be measured. moreover, carbon-dioxide 12CO2 13COs2 **** — since there is a mass difference, light absorption frequencies differ very slightly. Therefore, a diffraction grating 16 is rotated, an include angle theta is changed, and they are 12COs2. 13COs2 A light absorption spectrum is mostly measured to coincidence, and change of a carbon isotope ratio can be traced by asking for the ratio of both absorption intensity.
[0007] By the way, 12CO2 13COs2 The fine structure (vibration-rotation spectrum) of a light absorption spectrum changes, respectively, as shown in drawing 4 (a) and (b), and it is few. [of gaps of both spectrum] Moreover, each spectral band width of this fine structure is 0.1 at sample gas pressure 760Torr. By [cm-1] and Number Torr, it is very as narrow as 0.01 [cm-1] extent. Furthermore, 13CO2 / 12CO2 Since it is about 1%, relative isotopic abundance is 12CO2. Light absorption reinforcement is 13COs2. It is strong about 100 times.
[0008] It is 0.001 in order to measure such a spectrum correctly. Although the spectral decomposition ability more than [cm-1] is required, the spectral decomposition ability of the conventional analysis apparatus is 1 [cm-1] extent, and it is CO2. Since it is larger than the light absorption spectral band width of gas, can separate each spectrum of the fine structure and it cannot be measured. Consequently, an exact spectrum cannot be measured in response to the effect of the light absorption spectrum between carbon isotopes. Therefore, 12COs2 as shown in drawing 5 13COs2 The spectrum with which the spectrum lapped was measured.
[0009]
[Problem(s) to be Solved by the Invention] With the spectrum influenced [such] of mutual, it is 12CO2, for example. Even if concentration carries out small change very much, it is 13CO2. A spectrum is generated by the measurement error in response to effect. In the conventional analysis apparatus, although amended in quest of the mutual amount of laps based on a measurement spectrum by count, since the amount of laps between spectrums cannot fully be removed in the amendment, change of an isotopic ratio is untraceable with a sufficient precision.
[0010] Moreover, in sample gas, it is CO2. Since many impurities are contained besides gas and the impurity also absorbs light, the light absorption spectrum of an impurity is CO2. If it exists near the spectrum of gas, it will

become a measurement error in response to effect. Although it is necessary to make spectral decomposition ability high in order to remove the effect of this impurity as much as possible, the conventional analysis apparatus has low spectral decomposition ability as mentioned above.
[0011] Furthermore, in order to detect change of the carbon isotope of a minute amount very much, it is necessary to detect a light absorption spectrum by high sensitivity. Although sensibility can be made high in the above-mentioned conventional analysis apparatus if the large width of face of a slit 17 is taken, it is difficult for there to be opposite relation that resolution becomes low and to reconcile sensibility and precision.
[0012] The technical problem of this invention is to offer the carbon isotopic analysis equipment with a sufficient precision which can trace a carbonaceous isotopic ratio by high sensitivity, without the effect of the light absorption between carbon isotopes, the spectrum of an impurity, and being influenced of disturbance.
[0013]
[Means for Solving the Problem] This invention makes the semiconductor laser of the very narrow near-infrared region of emission spectrum width of face the source of a wavelength good light variation, irradiates this at sample gas, and is 12CO2. 13COs2 The intensity ratio of a light absorption spectrum is detected.
[0014] If it explains concretely, they are an AlGaAs system or InGaAsP. The semiconductor laser of a near-infrared region using a system ingredient is energetically studied and developed as optical communication and an object for optical information processing, and has become small, efficient, and high-reliability. Since the infrared region semiconductor laser of a lead salt system ingredient is not oscillated in ordinary temperature, the large-sized cooler by liquid helium, liquid nitrogen, etc. is needed, but it oscillates in ordinary temperature, and the semiconductor laser of a near-infrared region will serve as a source of a wavelength good light variation, if the temperature of semiconductor laser is controlled using a Peltier device.
[0015] If the semiconductor laser of a near-infrared region with such a practically excellent description is used, the whole equipment can be miniaturized very much and reliable equipment with easy and handling can be realized. The oscillation spectral band width of the semiconductor laser of this kind of near-infrared region is 0.0003-0.002. It is carrying out the sweep of the oscillation wavelength of this semiconductor laser to [cm-1], since it is very narrow, and is CO2. Each spectrum of vibration and rotation becomes measurable easily.
[0016] However, there are a spectrum suitable for isotopic ratio measurement and a spectrum which is not suitable as each spectrum of a measurable vibration and rotation. Therefore, on the occasion of measurement of an isotopic ratio, it is necessary to choose the optimal spectrum which fulfills the following conditions.
[0017] (1) 13CO2 The absorption intensity of a light absorption spectrum is 12CO2. Since it is weaker than absorption intensity about double figures, it is 13CO2. Light absorption reinforcement is strong and it is 12CO2. The spectrum which is not influenced of a spectrum is chosen.
[0018] (2) CO2 measured in a near-infrared region A light absorption spectrum is CO2. Although vibration of a molecule and a rotation spectrum are measured, since many other vibration feeble besides vibration made into the purpose and a rotation spectrum and rotation spectrums exist, the spectrum which is not influenced [other vibration and] of a rotation spectrum is chosen.
[0019] (3) 12CO2 13COs2 Since an optical spectrum is mostly measured to coincidence and it asks for an isotopic ratio from the absorption intensity ratio, it is 13CO2. An absorption spectrum and 12COs2 Be close at spacing with a suitable absorption spectrum.
[0020] (4) Since many impurities, especially moisture are contained in sample gas in addition to isotope gas, choose the spectrum which is not influenced of the light absorption spectrum of this moisture.
[0021] As a result of looking for the spectrum possessing the above-mentioned conditions in a near-infrared region, small was carried out very much, it suited, and things became clear.
[0022] Then, in this invention, it is based on a light absorption spectral intensity ratio, and is two or more carbon isotope 12CO2. 13COs2 In the isotopic analysis equipment which detects the isotopic ratio of the intermingled specimen The semiconductor laser of a near infrared ray, and the means which carries out the sweep of the oscillation wavelength of this semiconductor laser, The frequency modulation means which applies frequency modulation to this semiconductor laser, and the photodetector which detects the laser beam which passed the specimen in which it is emitted from this semiconductor laser and said two or more carbon isotopes are intermingled, It has the lock-in amplifier which detects adjustment with the modulation frequency obtained with said frequency modulation means, and the signal frequency of said laser beam detected with said photodetector. The luminescence wavelength of the semiconductor laser is the wave number 6253.73**0.2. 12COs2 at the time of [cm-1] As well as a light absorption spectrum, luminescence wavelength is the wave number 6253.90. 13COs2 at the time of being [cm-1] The intensity ratio with a light absorption spectrum was detected.
[0023] In addition, the combination of each left column of Table 1 and the right column can be used for detection of a light absorption spectral intensity ratio outside the combination of the luminescence wavelength of the above-mentioned semiconductor laser.
[0024]
[Table 1]

$^{12}CO_2$ (cm^{-1})	$^{13}CO_2$ (cm^{-1})
6254.67±0.2	6255.14±0.2
6255.58±0.2	6255.14±0.2
6257.29±0.2	6257.51±0.2
6258.88±0.2	6258.64±0.2
6261.01±0.2	6260.80±0.2
6261.65±0.2	6261.83±0.2
6252.77±0.2	6252.63±0.2
6251.77±0.2	6251.32±0.2
6249.67±0.2	6249.98±0.2
6228.69±0.2	6228.44±0.2
6231.72±0.2	6232.03±0.2
6233.19±0.2	6233.77±0.2
6226.35±0.2	6226.59±0.2
6223.13±0.2	6222.79±0.2

[0025]
[Function] The carbon isotopic analysis equipment of this invention is 12COs2 of the semiconductor laser of a near-infrared region. 13COs2 The sweep of the oscillation wavelength which is not influenced [an interaction and] of moisture is carried out, and incidence of the laser beam modulated with the frequency modulation means is carried out to the specimen in which a carbon isotope is intermingled. The laser beam by which incidence was carried out interacts with a carbon isotope, and resonance absorption of the part is carried out. And a residual light is detected by the photodetector and they are 12COs2 at a lock-in amplifier. 13COs2 A light absorption spectrum is measured.
[0026] 12COs2 13COs2 **** — since there is a mass difference, light absorption frequencies differ very slightly. Therefore, each light absorption spectrum is mostly measured to coincidence, and change of a carbon isotope ratio is traced by asking for the ratio of both absorption intensity.
[0027] In addition, the luminescence wavelength of semiconductor laser is 6253.73**0.2. 12COs2 at the time of being [cm-1] Light absorption spectrum, Similarly luminescence wavelength is 6253.90. 13COs2 at the time of being [cm-1] Combination with a light absorption spectrum and the combination of each left column of Table 1 and the right column are close at suitable spacing, and are 13CO2. Light absorption spectrums are 12COs2. It is not influenced of a spectrum.
[0028]
[Example] Hereafter, the example of this invention is explained to a detail with reference to a drawing.
[0029] Drawing 1 is the block diagram of the example of the carbon isotopic analysis equipment which applies this invention. 1 is the semiconductor laser of a near-infrared region, and 2 is 12COs2. And 13COs2 The sample cell which contains the intermingled sample gas, A current control section for the temperature control section for a photodetector and 6 to carry out a lock-in amplifier, and for sample gas exhaust and 5 carry out [3] the sweep of the wave number of semiconductor laser 1 in a sample gas inlet and 4, as for 7 and 8 to control the optical output of semiconductor laser 1 and 9 are oscillators which give modulation frequency to the current control section 8.
[0030] With the equipment of the above-mentioned configuration, the semiconductor laser 1 of a near-infrared region serves as a source of a wavelength good light variation by carrying out continuous oscillation in ordinary temperature, and carrying out the sweep of the temperature or the drive current of semiconductor laser 1. The temperature control section 7 carries out the sweep of the temperature, and the luminescence wave number of semiconductor laser 1 is the wave number 6253.90. [cm-1] and the wave number 6253.73 The continuation sweep of the [cm-1] neighborhood is carried out. Moreover, the drive current of semiconductor laser 1 is controlled to become a suitable optical output by the current control section 8. Furthermore, a current modulation is carried out by the signal of an oscillator 9, and frequency modulation is applied slightly.
[0031] Thus, incidence is carried out to a sample cell 2, and a wave number sweep and the laser beam from semiconductor laser 1 by which frequency modulation was carried out are 12COs2 in a cel here. Gas and 13COs2 It interacts with gas and a part is absorbed. The outgoing radiation laser beam from a sample cell 2 is detected by the photodetector 5. Only the signal with which the detected lightwave signal was able to take the oscillator 9 and the

[0039]
[Effect of the Invention] As explained to the detail, as mentioned above, with the carbon isotopic analysis equipment of this invention Since it was made the thing of the specific wave number which it was small, was reliable and approached the luminescence wavelength moderately, using semiconductor laser with the very narrow spectral band width of a near-infrared region as a source of a wavelength good light variation It is 12CO2, without the effect of absorption between carbon isotopes, and being influenced of spectrums, such as moisture. 13COs2 An isotopic ratio is [an isotopic ratio] traceable to high degree of accuracy and high sensitivity.

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synchronization by the lock-in amplifier 6 is detected. Consequently, the drift of the optical reinforcement of semiconductor laser 1 can be removed, and the good signal of a S/N ratio can be detected.
[0032] Thus, the detected lightwave signal serves as primary differential of light absorption reinforcement. Therefore, it sets to the infrared-absorption-spectrum Fig. of drawing 2 formed of this example, and is the wave number 6253.90. [cm-1] and the wave number 6253.73 12COs2 intermingled in a sample cell 2 if it asks for the ratio of an absorbed amount in quest of the peak value of both the detecting signals of [cm-1], or the area of absorption Gas and 13COs2 A ratio with gas, i.e., an isotopic ratio, is called for easily.
[0033] Furthermore, if only a twice as many frequency component as the signal oscillated with the oscillator 9 is detected by the lock-in amplifier 6, the secondary differential configuration of light absorption reinforcement can be measured. It is the wave number 6253.90 like the above. [cm-1] and the wave number 6253.73 If it asks for the ratio of the peak value of both the detecting signals of [cm-1], an isotopic ratio can be found easily. And by this method, since the secondary differential configuration of light absorption reinforcement is measured, primary change and secondary change by which outgoing radiation was carried out from semiconductor laser 1 are canceled, it is more highly precise and an isotopic ratio can be measured.
[0034] In addition, at this example, the luminescence wavelength of semiconductor laser 1 is the wave number 6253.73**0.2 to detection of a light absorption spectral intensity ratio. 12COs2 at the time of being [cm-1] Light absorption spectrum, Similarly luminescence wavelength is the wave number 6253.90. 13COs2 at the time of being [cm-1] Although the light absorption spectrum was used Besides this combination, luminescence wavelength is the wave number 6254.67**0.2. 12COs2 at the time of being [cm-1] Light absorption spectrum, Luminescence wavelength is the wave number 6255.14**0.2. 13COs2 at the time of being [cm-1] A light absorption spectrum and luminescence wavelength are the wave number 6255.58**0.2. 12COs2 at the time of being [cm-1] Light absorption spectrum, Luminescence wavelength is the wave number 6255.14**0.2. 13COs2 at the time of being [cm-1] A light absorption spectrum and luminescence wavelength are the wave number 6257.29**0.2. 12COs2 at the time of being [cm-1] Light absorption spectrum, Luminescence wavelength is the wave number 6257.51**0.2. 13COs2 at the time of being [cm-1] A light absorption spectrum and luminescence wavelength are the wave number 6258.88**0.2. 12COs2 at the time of being [cm-1] Light absorption spectrum, Luminescence wavelength is the wave number 6258.64**0.2. 13COs2 at the time of being [cm-1] A light absorption spectrum and luminescence wavelength are the wave number 6261.01**0.2. 12COs2 at the time of being [cm-1] Light absorption spectrum, Luminescence wavelength is the wave number 6260.80**0.2. 13COs2 at the time of being [cm-1] A light absorption spectrum and luminescence wavelength are the wave number 6261.65**0.2. 12COs2 at the time of being [cm-1] Light absorption spectrum, Luminescence wavelength is the wave number 6261.83**0.2. 13COs2 at the time of being [cm-1] A light absorption spectrum and luminescence wavelength are the wave number 6252.77**0.2. 12COs2 at the time of being [cm-1] Light absorption spectrum, Luminescence wavelength is the wave number 6252.63**0.2. 13COs2 at the time of being [cm-1] A light absorption spectrum and luminescence wavelength are the wave number 6251.77**0.2. 12COs2 at the time of being [cm-1] Light absorption spectrum, Luminescence wavelength is the wave number 6251.32**0.2. 13COs2 at the time of being [cm-1] A light absorption spectrum and luminescence wavelength are the wave number 6249.67**0.2. 12COs2 at the time of being [cm-1] Light absorption spectrum, Luminescence wavelength is the wave number 6249.98**0.2. 13COs2 at the time of being [cm-1] A light absorption spectrum and luminescence wavelength are the wave number 6228.69**0.2. 12COs2 at the time of being [cm-1] Light absorption spectrum, Luminescence wavelength is the wave number 6228.44**0.2. 13COs2 at the time of being [cm-1] A light absorption spectrum and luminescence wavelength are the wave number 6231.72**0.2. 12COs2 at the time of being [cm-1] Light absorption spectrum, Luminescence wavelength is the wave number 6232.03**0.2. 13COs2 at the time of being [cm-1] A light absorption spectrum and luminescence wavelength are the wave number 6233.19**0.2. 12COs2 at the time of being [cm-1] Light absorption spectrum, Luminescence wavelength is the wave number 6233.77**0.2. 13COs2 at the time of being [cm-1] A light absorption spectrum and luminescence wavelength are the wave number 6226.35**0.2. 12COs2 at the time of being [cm-1] Light absorption spectrum, Luminescence wavelength is the wave number 6226.59**0.2. 13COs2 at the time of being [cm-1] A light absorption spectrum and luminescence wavelength are the wave number 6223.13**0.2. 12COs2 at the time of being [cm-1] Light absorption spectrum, Luminescence wavelength is the wave number 6222.79**0.2. 13COs2 at the time of being [cm-1] A light absorption spectrum may be used and a suitable result is obtained like the above.
[0035] Moreover, although temperature control of the semiconductor laser 1 of a piece was carried out and the sweep of the luminescence wavelength was carried out in this example, you may make it the configuration which controls the drive current of semiconductor laser 1 and carries out the sweep of each wave number neighborhood, or coincidence may be made to oscillate the laser beam of each wave number neighborhood using two semiconductor laser 1, and incidence may be carried out by turns into a sample cell 2.
[0036] Furthermore, although the current modulation is performing the frequency modulation of semiconductor laser 1, EO modulator (Electro-Opyic Modulator) may be formed outside and it may become irregular.
[0037] Thus, at this example, it is 13CO2. The light absorption reinforcement of gas is strong, and it is 12CO2. Since two kinds of spectral intensity which is not influenced of an interaction with gas, moisture, etc. was measured by the lock-in amplifier 6, the effect of disturbance is removable.
[0038] Moreover, since emission spectrum width of face was very narrow, was small, made semiconductor laser light of a reliable near-infrared region the source of a wavelength good light variation and has moreover measured by the lock-in amplifier 6, using this about 100%, an isotopic ratio can be measured by high degree of accuracy and high sensitivity, and reliable carbon isotopic analysis equipment can be realized.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing one example of the carbon isotopic analysis equipment which applies this invention.
[Drawing 2] CO2 measured by this example It is an infrared-absorption-spectrum Fig.
[Drawing 3] It is the block diagram showing an example of conventional isotopic analysis equipment.
[Drawing 4] (a) is 12COs2. An infrared-absorption-spectrum Fig. and (b) are 13COs2. It is an infrared-absorption-spectrum Fig.
[Drawing 5] CO2 measured by conventional isotopic analysis equipment It is an infrared-absorption-spectrum Fig.
[Description of Notations]
1 Semiconductor Laser
2 11 Sample cell
3 12 Sample gas inlet
4 13 Sample gas exhaust
5 18 Photodetector
6 Lock-in Amplifier
7 Temperature Control Section
8 Current Control Section
9 Oscillator
10 Lamp
15 Mirror
16 Diffraction Grating
17 Slit

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